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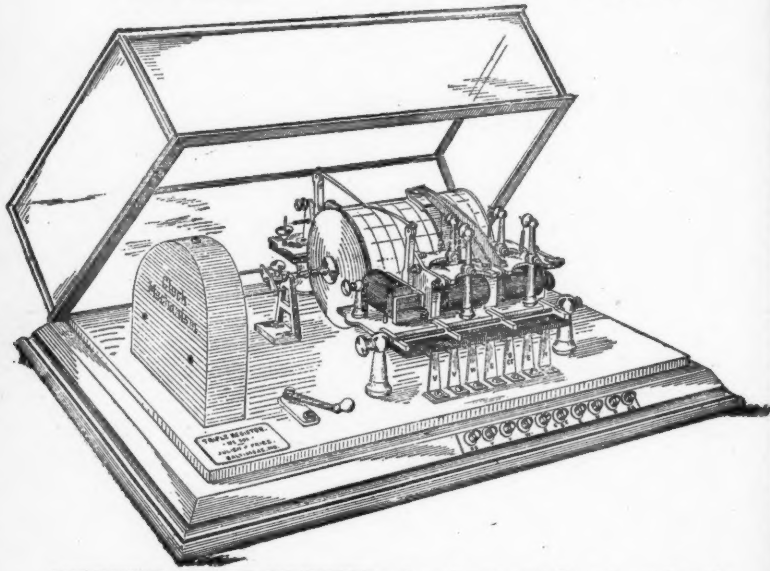

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THE AMERICAN

METEOROLOGICAL JOURNAL.

VOL. XI. BOSTON, MASS., JUNE, 1894. No. 2.

THE TEXAN MONSOONS.*

MARK W. HARRINGTON.

BY seasonal winds is meant those which continue in the same direction for periods which are measured by months and recur in the same seasons. The ordinary charts giving the resultant or average direction do not admit of safe conclusions on such winds. On the contrary, the tendency is to eliminate them. For instance, if at any station the wind was generally north for one half of the year and south for the other half, except as modified by cyclonic or anticyclonic action, the last would, though exceptional, give character to the charts, and the more interesting periodic wind might be completely eliminated.

In order to ascertain the locality and character of annually recurring winds of considerable duration, maps were constructed showing the most frequent winds for each month of the year. The tables employed were the manuscript ones of the Weather Bureau, which give the mean monthly frequency for the eight principal points of the compass for the tri-daily observations from 1871 to 1886 inclusive. The tri-daily observations were used because they would give less prominence to land and sea breezes than would the later bi-daily observations. On these charts were marked all winds occurring with a frequency of two-eighths of all the observations or more, and the same for three-eighths, four-eighths, and five-eighths. Of the latter there were only three cases. Alaska was, of course, omitted, as we have few data from that region.

* Reprinted from the Bulletin of the Philosophical Society of Washington, Vol. XII., pp. 293-308.

The completed charts show the stations where for any month the wind was twice, thrice, four, or five times as frequent in any direction as would be the case if the winds were uniformly distributed. This was taken to indicate the most frequent winds and to point out the regions deserving more detailed study. Inspection of the maps showed the following cases where there was a distinct seasonal change in wind direction: —

I. The Texan Monsoons, extending up the plains, sometimes beyond the limits of Texas, and even to the northern boundary of the United States.

II. The California Monsoons, occurring on the Pacific coast, south of San Francisco, and reaching up the Sacramento and San Joaquin Valleys.

III. The Willamette and Puget Sound periodic winds.

IV. The northeast and southwest winds of the Atlantic coast.

V. The off-coast winds in winter above Cape Henry.

VI. Isolated cases, as Escanaba, Duluth, Las Animas, and Winnemucca.

Aside from these, the direction of greatest frequency of the wind is generally westerly over the entire country. In the Great Basin the indications are somewhat ambiguous. Over the great lakes it is generally west or southwest. Over the more northern part of the Rocky Mountain region it is west or northwest, while in the southern part (Arizona) it is westerly, but there seems to be no decided preponderance of the northwest winds over the southwest ones.

Several of these winds are designated as monsoons. A monsoon is, so to speak, an annual land and sea breeze. It is a wind that changes its direction twice a year because of the differences in temperature of the continental and oceanic surfaces over which it flows. In summer the land surface is the warmer and deflects the wind toward itself. In winter the oceanic surface is the warmer and deflects the wind in its direction. It is not necessary that there be a complete reversal of direction, though this happens in the case of the best known monsoons — those of southeastern Asia. The monsoon can also be defined in terms of the atmospheric pressure. The wind flows from the region of higher to that of lower pressure. In the case of large adjacent areas of land and water (especially if the land is bare of forests, and

still more if it is a desert tract) the higher pressure is over the land in winter and over the ocean in summer. The wind is in this case alternately deflected toward the land and the ocean, giving rise to a monsoon. As the relatively high temperature of one and the low temperature of the other is the cause of the differences of pressure, this conception is really only another form of the preceding.

The occurrence of monsoonal winds on the North American continent has been but little discussed. As early as 1853 Mr. Lorin Blodget called attention to the summer southeast wind of central Texas and called it a true monsoon,* and in 1875 Professor Coffin discussed † the monsoonal features of the United States in general terms. General Greely, dissenting from these views, says that he "cannot agree with those who credit the United States with monsoonal winds." ‡ This may be considered by him a question of definition rather than a question of fact, as he says the attempt to apply the name monsoon to wind systems of other regions than those of southern Asia has not gained general consent. With this Prof. Ferrel does not agree, for on his discussion of monsoons are founded the definitions above given. Besides, to extend the name of a typical phenomenon to all the phenomena of the same type is a common custom and a very convenient one. Prof. Ferrel points out § that to have well marked monsoons the continental area must have elevated plateaus or be backed by high mountains. These elevated regions serve something like a chimney flue for the inflowing air when they are heated, and increase the velocity of the outflowing air when chilled. It is a requirement of prime importance and is overlooked by most writers on the subject. It is a condition which exists in the United States, and its influence can be distinctly seen in each of the cases of marked monsoons mentioned. Indeed, Prof. Ferrel, with a rare combination of both analytic and synthetic powers, not

* Amer. Assoc. Adv. Sci. Proceedings, 7th Meeting, held in Cleveland, Ohio, July, 1853. 8°, Cambridge, 1856 [vol. 7], p. 177.

† Coffin (J. H.). Winds of the globe, being Smithsonian contributions to knowledge. Vol. 20, fol., Washington, 1875.

‡ Greely (General A. W.). American weather. 8°, New York [1888], p. 164.

§ Ferrel (William). Popular treatise on the winds. 8°, New York, 1890, chapter v, pp. 193–226.

only analyzed the monsoon as a type and pointed out its essential features, but he also indicated the parts of the earth's surface on which monsoons may be found. He apparently depended for this, not on the examination of the weather maps and monthly charts, but on general principles. Nearly every one of the special winds mentioned here were indicated by him in general terms. The only work with regard to them that he left to do was to fill in the details of the pictures which he had sketched in general outline. For the Texan monsoons such details will now be given as can be drawn from the daily weather maps and from the study of the monthly maps of greatest frequency already referred to.

They are in-coast and off-coast winds, and are south and southeast, north and northwest on the coast and in Texas, but become southerly or northerly winds when they extend far up on the plains. Up toward the Dominion border they pass imperceptibly into the prevailing southwesterly and northwesterly winds. A separate discussion of the southerly (summer) and northerly (winter) yields the clearest understanding of them.

(*a.*) THE SOUTHERLY WINDS OR SUMMER MONSOON.

These first appear distinctly in March, when they occupy the territory south of a line drawn from Texarkana to the mouth of the Pecos River. Their eastern limit is not well defined, either in this or the succeeding months.

In April the territory occupied by them is somewhat larger. It now lies to the southeast of a line drawn from Fort Sill, in the southwestern part of Indian Territory, to the mouth of the Pecos.

In May it extends to a meridian perhaps fifty miles westward, and swells northward until it reaches the Dakotas, Minnesota, and Wisconsin — in fine, it extends fairly to the Dominion boundary. From June to September it remains about the same. In October it is as in May, and in November it disappears.

It is most extensive from May to October, when it occupies a territory ten degrees of longitude (about five hundred miles) wide and fifteen degrees of latitude (about one thousand miles) long.

The examination of the daily weather maps for the year 1891 and for fractions of other years brings out several noteworthy features in the relation of these southerly winds to cyclones

and anticyclones. This northward draft of air between the Rocky Mountains and the Mississippi River is frequently disturbed and modified by these independent wind systems. Sometimes the reach of the southerly winds is increased thereby; sometimes it is decreased; sometimes it is suppressed, especially in the earlier and later months. Very rarely, however, are they entirely suppressed during the summer months. They are apt to persist through all weather along the coast, especially west of Galveston, and they show an invincible determination to extend themselves northward through every gap where they can force their way. They frequently overcome the winds in the southwest quadrant of a cyclone lying immediately northeast (when the cyclonic winds are from the north), and in more than one case they were found pouring through between cyclone and anticyclone when the currents of both these systems were against them. For the first, see the weather maps for May 18, 26, P. M., and June 7, P. M.; for the last see June 20, all in 1891.

But the wind systems of the cyclone and anticyclone are not always unfavorable. Sometimes they act in the same direction as the monsoon, in which case they extend it northward until it may reach beyond our northern frontier.

An examination of the individual effects of cyclones and anticyclones, resulting from their geographical position, brings out several results, some of which are unexpected. Cyclones west of the continental divide have no appreciable effect. As they pass over the divide north of Texas they promote the northward extension of the southerly winds, until the centre passes the meridian of eastern Texas. After that they tend to suppress the southerly winds, but they generally have much less influence when retreating than when advancing. When a cyclone passes along Texan latitudes and over that State there is less effect than might be expected. When a cyclone forms in Texas or in the adjacent part of the Gulf, the effect on the southerly winds is very marked. This is especially true in the initial stages of a cyclone. In such cases the Texan winds are in confusion, and it is only by examining subsequent maps that the causes are manifest. As soon as the development of the cyclone has reached such a stage that the isobars and isotherms are irregular and bent, but before a distinct area of low pressure can be de-

tected, the southerly winds yield the struggle and the wind vanes set to all directions.

The anticyclone has decidedly more effect than the cyclone, as might be expected, seeing that it reverses the slope of the isobaric surfaces. An interesting fact is that the anticyclone effect on the Texan southerly winds is more pronounced when it is east of the Mississippi River than when west of it. An anticyclone over the upper lakes has greater effect than one culminating in the Dakotas. One central in Tennessee or even in Alabama will have, while one off the Georgian coast may have, a marked effect. Even from Ontario it may have greater effect than to the westward.* On the A. M. map of July 22, 1891, an anticyclone over Maine appreciably disturbed the southerly winds in Texas.

When an anticyclone is over or near Texas it controls the winds generally. It may set them only one or two points away from the north or it may reverse them.

The weather maps are now based on observations taken at 8 A. M. and 8 P. M. of Eastern standard time. This is about 6 A. M. and 6 P. M. by Texas local time. An inspection of the maps shows that the disturbances of the southerly winds caused by cyclones and anticyclones are appreciably greater in the early morning than in the early evening. This is probably due to the fact that the temperature is at about its minimum at 6 A. M. in summer, and a wind due to differences in temperature of land and water would be weaker at that time than at 6 P. M., —a few hours after the daily maximum of temperature.

To make a thorough investigation of the velocity of the southerly winds would require a collation of the records by hours and days for the winds from different directions. This is an arrangement of the data which is not usually made, and it has not as yet been made in the Weather Bureau. It would require a great deal of labor to make it. The record sheets of the registering anemometers show, on glancing through them and taking only the cases where the southerly winds are fairly independent of cyclonic or anticyclonic action, that these winds often continue day and night, but with a decrease of velocity in the morning

* See War Department Weather Map for June 20, 1891, and the days immediately following.

hours. As a typical case, the record at Abilene, which is far inland, for the dates Aug. 13 to Aug. 21, 1891, shows that the mean velocities for the south and southeast winds during this time were as follows: —

WIND VELOCITIES AT ABILENE, TEXAS, AUG. 13 TO AUG. 21, 1891.

Hours.	Miles per Hour.	Hours.	Miles per Hour.	Hours.	Miles per Hour.	Hours.	Miles per Hour.
Midnight.	9.7	6 A. M.	9.6	Noon.	11.8	6 P. M.	13.8
1 A. M.	9.1	7 "	8.1	1 P. M.	10.5	7 "	13.9
2 "	9.3	8 "	9.7	2 "	12.2	8 "	11.0
3 "	9.6	9 "	12.2	3 "	12.7	9 "	10.1
4 "	9.2	10 "	12.9	4 "	13.5	10 "	10.6
5 "	9.8	11 "	11.9	5 "	12.6	11 "	10.4

Dr. I. M. Cline, of Galveston, states that "the south winds in midsummer in the central portion of the State do not, under ordinary circumstances, change during the night, but continue from the south, although with less velocity early in the morning than at other times during the day."

The summer monsoon winds in Texas are somewhat gentler than the winter ones, but this is generally true for winds in temperate latitudes. High winds in Texas in summer are usually cyclonic ones.

Another feature of interest shown by an examination of the weather maps is that these winds usually give clear weather except when cyclonic conditions approach. They then give a fair or overcast sky and cause an extension toward the south of the cyclonic cloud-cap. Occasionally, under these circumstances, isolated patches of rain may appear.

Dr. Cline points out a secondary or resultant condition to the west of the monsoon region. During the summer monsoons, in dry seasons, to the west of the meridian of 98°, there is occasionally a hot southwest wind resembling the chinook or foehn winds, which sometimes lasts for nearly a week; they are brisk, dry, hot, and more or less injurious to certain classes of vegetation. They are occasionally observed between the middle of

June and the middle of August and appear to result from an area of low pressure central to the north of Texas, which causes the southeast winds to back to the southwest. The best defined wind of this character, and one which was the cause of general remark at the time, occurred from July 17 to 19, 1886, but such winds were not afterwards noticed to any extent until they were reported from June 18 to 22, 1891.

(*b.*) THE NORTHERLY WINDS OR WINTER MONSOONS.

On the monthly charts of prevailing winds, the north winds first appear distinctly in December. They then occupy the most of Texas east of the one hundredth meridian, with the same indefiniteness, as before, as to the eastern limit. On the January map their territory is not appreciably larger, while on the February map it is somewhat smaller. On the March map these winds do not appear at all.

From an examination of the weather maps it appears that occasional north winds, lasting several days, may occur in all months except the summer ones. They are occasional during the spring and autumn, and prevalent and often long-continued during the winter.

They occur, for the most part, with anticyclones in latitudes north of Texas and east of the meridian of 110°. The control of the Texas winds by these centres in winter continues as the latter travel eastward until the latter approach or even reach the Atlantic coast. Whatever the position of the centre of high pressure, within the limits above given, its effect in Texas, and sometimes far northward, is to give generally north winds.

There are also north winds of cyclonic origin, covering much more territory in the rear of cyclones in winter than in summer. An illustration can be found on the weather map for Dec. 25, A. M., 1890. In the case of the rare cyclones with a cold centre, which is apparently an ordinary cyclone turned upside down, it is, of course, the advancing or eastern side which promotes the occurrence of north winds over the plains and in Texas. Such a case may be found on the morning weather map for Feb. 25, 1891.

The winter north winds differ from the summer south ones in several respects other than those of direction and season. They are less persistent under adverse circumstances. They

show less determination to push their way and are more easily suppressed, even in the midst of their proper season. They are most easily displaced on the coast, while the south winds are most persistent there. Indeed, they sometimes exist in the interior, while they are not present on the coast. For an illustration, see the weather maps for the morning and evening of Nov. 28, 1891.

The north winds are usually clear or clearing. Their velocity is generally higher than that of the summer south winds. They cause a fall in temperature, but this is often slight. Occasionally the cyclonic or anticyclonic conditions are especially favorable to the setting up of the north winds. When this happens, and especially when both combine to the same effect, the north winds may come down the plains with great velocity, with a sharply defined head of cloud like a battering ram, replacing warm and stagnant air and causing a sharp and great fall of temperature. These are the well-known Texas "northers." The "northers" are thus exaggerated cases of the prevailing north winds of winter on the southern part of the plains. They may also occur during the spring and autumn, and are then more noticeable to the residents because the chill they bring is more appreciable, and because a wind from the north is then less usual. When the conditions under which they are formed are especially favorable, they push their way far southward. They give tempestuous weather over the western part of the Gulf of Mexico. They even sometimes bring frost and snow on the highland coffee plantations of Guatemala and Honduras, and, crossing the peninsula of Tehuantepec, they are sometimes encountered by ships far toward the equator on the Pacific Ocean.

The conditions especially favorable to the formation of "northers" fall easily under two types. The first, or essentially cyclonic type, was recognized by Prof. Ferrel. It is where a warm winter cyclone is closely followed by a mass of cold air. The pressure in the rear of the cyclone rises sharply, the heavy air behind, coming directly from the north, presses closely on it, and a sharp fall of temperature with northerly winds results. This is most common with winter cyclones originating in or crossing the western gulf or southern Texas. The warm vapor-laden air is suddenly displaced by the cold, dry, piercing air from the north, and the very contrasts between the two unlock ener-

gies which promote the latter. Good specimens of this type can be seen on the weather maps for the forenoon of Dec. 3, 1890; also the afternoon of Dec. 7 and morning of Dec. 8; also the afternoon map of Jan. 1, 1891, and again for the forenoon of March 8, 1891.

The second type is anticyclonic. An anticyclone of especial intensity, or in an especially favorable position, sends a great stream of northerly winds down the plains, and these, replacing the milder air there, produce phenomena like the preceding, though generally not so marked. Illustrations can be found on the weather maps for Nov. 18, 1890, and the forenoon of Feb. 4, 1891.

In connection with the winter monsoons when cyclonic and anticyclonic conditions both favor the north winds, Dr. Cline has noted a character of cloud which is more common than any other. It has the appearance of several large rolls or sheets of black cotton batting each rolling over the other and extending from east to west above the prairie until they pass from view below the horizon. The appearance of these clouds is very striking.

It appears, therefore, that over Texas, and often far to the northward, there is a periodic seasonal wind, the air flowing northward in summer, southward in winter. In so far these winds have the ear-marks of monsoons proper, with complete reversal of directions. They have the necessary proximity of land and sea, the existence of great plains nearly bare of forest vegetation and gradually increasing in elevation above sea-level, and the necessary background of high mountains. To put the case beyond the possibility of doubt, it remains to be seen if these winds have the other ear-marks of the monsoons.

First, the continental area must have a higher temperature in summer and a lower in winter. That the latter must be true is so self-evident that it is not necessary to refer to the meteorological charts for its proof. The winter air over the semi-tropical Gulf must be decidedly warmer than that over the bare continental plains to the north. As to the summer, it is evident that the continental plains must be warmer in the daytime, cooler at night. The more elevated plains become the warmer compared with air at the same level over the ocean. Late in the afternoon this difference reaches a maximum and may be

very great, and a strong inland northerly current is in progress. This condition lasts well into the night and again begins the next morning immediately after sunrise. Whether the cooling to the minimum at sunrise is enough to greatly retard this northward movement, or even to bring it to rest and perhaps start a return current, is a matter for observation to decide. The decision appears to be in the negative, which is in accordance with the facts in other monsoon regions. Moreover, if a return even started during the night the phenomenon would become a simple land and sea breeze, and the theory of such a breeze is absurd when applied over a territory part of which is from five hundred to one thousand miles from the sea.

Charts representing isotherms reduced to sea-level (when this reduction is correctly made) may be safely used in the study of monsoonal winds, for the contrast of temperatures at any level, to which the motion is due, is the contrast between the temperature of the plain and that of air at the same sea level in adjacent lower regions. As the temperature decreases more rapidly in a vertical direction in free air than on the slopes of mountains, the charts of isotherms reduced to sea-level must show smaller contrasts of temperature than are actually existent for producing monsoons. Armed with this fact, Dr. Hann's excellent chart of July isotherms for the globe may be examined.* It is here found that the reduced temperature of Texas, Oklahoma, Colorado, and the western parts of Indian Territory and Kansas have about the same mean temperature as the western Gulf and Yucatan. As the elevation of the States is greater, a steady monsoon from the south in July should result, except in so far as it is interrupted by cyclonic and anticyclonic action. The same thing would in its degree be true for the neighboring months.

The other test to apply is that of the differences in atmospheric pressure between the plains and Gulf in summer and winter. Here, again, it is safe to employ charts with the isobars reduced to sea level. Turning to Dr. Hann's isobaric chart for January, it appears that the mean pressure increases from the Gulf northward, culminating in the Dakotas and Montana. The mean difference between the Gulf and this centre in

* Hann (Julius). Juli-Isothermen. [*In* Berghaus (*dr*. H.) Physikalischer atlas, etc., fol. Gotha, J. Perthes, 1886. Map No. 29.]

January is five millimeters, or a fifth of an inch, — sufficient to give the air a tendency to move southward over the plains. In July the isobar of 760 millimeters runs nearly along the hundredth meridian from the foot of Yucatan to Manitoba, while there is lower pressure to the northward and southward, with, on the whole, a more rapid decrease to the northward. On the more detailed forenoon and afternoon normal-pressure charts for the months, now in manuscript in the Weather Bureau, increase in pressure from north to south in July is decidedly greater, being about a fifth of an inch. These charts are probably based on a larger number of synchronous observations taken with carefully compared instruments than are Dr. Hann's, being from fifteen years of the records of the Signal Service.

It appears, therefore, that, on the whole, the requirements for monsoons are present, but that the resulting monsoons are very much disturbed (sometimes promoted, sometimes suppressed) by the cyclones and anticyclones that are almost constantly crossing their area. There remains to be made the explanation of the fact that the summer monsoons last longer and are more persistent than the winter ones. This is the more difficult because all the conditions already mentioned are more favorable for the winter north winds than for the summer south winds For this there seems to be no better way than to fall back on the mean wind direction prevailing in summer over the Gulf. The trade winds in summer flow into the Gulf from the east and southeast, and reach the Texan coast nearly perpendicular to it. On the land, the surface winds are forced northward by the continental divide. Thus the gentle summer monsoons receive a push from behind, and this gives them more persistency and constancy than the more distinctly monsoonal and more violent winter winds from the north. Here, again, are reproduced the conditions of the monsoons of the Indian Ocean, more especially those of the Arabian Sea, where there exists a very similar aid from the general circulation.

To summarize, briefly, for this interesting set of monsoons : —

The air flows northward from the western part of the Gulf of Mexico from March to October, and in the summer reaches our northern boundary along a strip about ten degrees wide. It flows south during the winter in Texas, but is subject to sudden

accessions called "northers," due to cyclonic or anticyclonic action. This action also frequently disturbs the summer south winds, and the latter are re-enforced by winds prevailing during their season in the Gulf.

These winds play a very important part in the climate of all Texas, except the extreme west. The southerly winds (or southeasterly toward the central or western part of the State) bring coolness and comfort with them in the very season coolness is most needed. The surgeon of the military station at Austin says:* "Although the sun is extremely hot in summer, the temperature of the atmosphere is much modified by the southeasterly breeze that blows almost continuously during the twenty-four hours." At Fort McKavett, which is northwest from San Antonio and about as far from that place as the latter is from the coast, the surgeon speaks of† "the delightful breezes of morning and evening throughout the latter part of the spring and the entire summer and fall." Fort McKavett is near the western margin of the summer monsoon. At Fort Richardson, near the Red River and south of southwestern Indian Territory, these winds are referred to as constant.

The north winds or winter monsoons are not so favorable for Texas, but at the same time they are not less favorable than are the prevailing westerly winds over the States far to the north of it. The "norther" is an occasional phenomenon, not more common than the "cold wave" of the upper Mississippi valley. Severe and destructive "northers" are quite exceptional.

The eastern limit of the Texan summer monsoons has already been referred to as not easy to define. There is no good evidence of them east of the Mississippi River south of the Ohio except on the Gulf coast. A prevailing south wind in June occurs at Cairo, but not below that place until the vicinity of the Gulf is reached. New Orleans has a northeast wind more than a quarter of the time in May, but no wind there reaches this frequency during the other months of the year. With Mobile the case is different. A south wind is the most frequent there from March to June, agreeing so far with the summer

* United States War Department, Surgeon General's office. Report on the hygiene of the United States Army, etc. 8°, Washington, 1875, p. 183.

† *Ibid.*, page 217.

monsoon, but it fails with July, just when this monsoon is best established in Texas and northward. In September a prevailing north wind sets in, two months before it sets in on the Texan coast, and this wind continues until February. A south or southwest wind prevails at Pensacola from May to July and a north wind occurs in winter, reaching, however, a frequency of one fourth only in November.

It appears that on the Gulf coast the monsoons are felt at Mobile and perhaps a little further eastward. The winter monsoon comes on prematurely at Mobile.

THE MARINE NEPHOSCOPE AND ITS USEFULNESS TO THE NAVIGATOR.*

PROF. CLEVELAND ABBE.

THE object of the marine nephoscope is to enable the navigator to observe the motions of the clouds, either upper or lower, as easily as he observes the winds. He may not only deduce therefrom the location of a storm centre at any moment, which knowledge he needs for his own safety, but may also put on record the data by means of which other students can determine the actual heights and motions of the clouds which will be needed in the further advance that meteorology is sure to make.

I would not assert that we have as yet all the data needed by which the navigator can quickly determine the distance and direction of the storm centre at any moment; but we have here the long-needed instrument; and I will indicate the method of using it, and the further general process of reasoning, in hopes that this may attract the attention of the navigator to the practical value of the marine nephoscope. The instrument and its use are so simple, and the interest that attaches to the subject is so great, that it is important that navigators in both naval and merchant marine should learn its use and record the motions of the clouds as regularly as they do other meteorological items.

In the gradual development of our knowledge of storms we have historically passed through many stages, *e. g.*, (1) the

* Reprinted from the Report of the International Meteorological Congress, Part I. pages 161–167.

study of the winds ; (2) the study of individual, local, or isolated barometric depressions, namely, the simple rising and falling of an individual barometer ; (3) the study of the differences or departures of observed barometers from the normal or average readings of the same instruments at the same altitude above sea level ; (4) the study of the relative pressures at many stations, all reduced to sea level, and of late years also reduced to standard gravity ; (5) the study of the departures of the individual readings, reduced to sea level, from the average pressure proper to the small circle of latitude round the whole globe. Incited by the investigations of Guldberg and Mohn, of Ferrel, and other leaders, meteorologists have of late years paid special attention to the angle between the wind and the isobar ; but isobars cannot be drawn or used by the mariner at sea, neither should the isobar be considered to the exclusion of the effects of temperature and moisture in altering the density of the air ; therefore, both for practical and theoretical reasons, the navigator must confine his attention to the angle between the direction toward which the wind is moving at the observer's station and the direction in which the storm centre lies with reference to his station.

By storm centre we shall in this paper mean the central point about which rotates a system of whirling winds. We must distinguish between this centre of winds and the barometric storm centre, which latter is defined as the centre of the smallest isobaric circle or ellipse. This latter is the storm centre of modern dynamic meteorology ; the former is the storm centre of the mariner and of the older cyclonologists. These centres are often identical, but not necessarily always so. Mechanical principles have of late years required us to study the relations of the winds to isobars and isabnormals ; but having done this we must now return to the older problem and, for the use of the mariner, must apply our increased knowledge to the study of the simple geometrical problem that he has to do with, namely, the relation between the movement of the wind and the bearing and distance of the storm centre.

As the direction of the wind is so minutely observed by navigators who understand how to determine its true direction, notwithstanding the motion of the vessel on which they are sailing, it should be easily possible by the accumulation of weather maps

to determine the direction and incurvature of the wind on all sides of the storm centres at sea. Therefore, up to the present time the navigator has relied upon the wind and its changes to indicate to him the location and movement of the storm centre that he wishes to avoid.

The progress of our knowledge of the motions of the upper and lower currents of air in the neighborhood of a well-defined hurricane centre has made it apparent that we may improve upon the old rule of the earlier cyclonologists who assumed that the wind blew in a circle around a hurricane centre and who, therefore, stated that if in the northern hemisphere the navigator stand with his back to the wind he will have the centre on his left hand.

This rule was always recognized as rather crude, yet for a long time nothing better was offered for the use of mariners, notwithstanding the fact that the charts of Redfield, Espy, Loomis, Lloyd, and Leverrier all showed that the rule is not a law of nature. The fact that the winds are inclined inward, as compared with the path required with the truly circular theory, was stated very emphatically by Redfield in 1846, and he adds that in his charts of storms the engraver had sometimes drawn the winds in accordance with the old theory, contrary to Redfield's better judgment. He states that the average inclination of the wind to the circular tangent rarely exceeds two points of the compass, and is never so much as was often claimed by Espy; but it seems to me that the fact should not be lost sight of that the land storms studied by Espy and the ocean hurricanes studied by Redfield are two modes of motion in the atmosphere that are often essentially different from each other.

The rules for locating the centre of a hurricane and for determining the direction of its motion, hitherto used by navigators, have been based largely upon the study of the direction of the wind, but this is subject to considerable local irregularities if the mariner is in the neighborhood of any land; moreover, the inclination of the wind to the radius from the storm centre varies largely with the latitude and the position with regard to that centre. Numerous studies, especially those of Broun, Ley, Hildebrandsson, Ekholm, and Clayton, have shown that the movement of the wind is subject to considerable irregularity; and if the navigator can avail himself of the direction of motion of

the clouds he may locate the storm centre with much greater accuracy. The most extensive series of observations of upper and lower clouds is that published by Broun in the annual volumes of his observations at Makerstoun, Scotland, for 1843–'46, which form a part of the transactions of the Royal Society of Edinburgh. As the result of about three thousand observations Broun found that the lower cumulus scud is inclined outward to the winds by 14.5°; the next layer above, or cirro-stratus, inclines outward 22.8°; the highest layer of clouds, or true cirri, is inclined outward 29.6°. These observations were for many years overlooked until, in 1871–72, both Clement Ley and myself, by the study of English and American observations, respectively, independently announced the general rule, almost in the words that Broun had used twenty-five years before, that as we ascend in the atmosphere the angle by which the movement of a given layer differs from the movement of the lowest wind deviates more and more to the right. As a result of the work that has hitherto been done on this subject, I think we may for the present adopt the general rule that between the winds that blow spirally inward and the upper clouds that blow spirally outward there is an intermediate layer of the so-called lower clouds whose motion is very nearly along a circular arc, and that the mariner may more safely locate his storm centre as being in a line perpendicular to the motion of the lower clouds rather than to rely entirely upon the surface winds. If he observe the angle between the movements of the wind and the lower clouds and again between the lower and the upper clouds, he has a further means of determining even the distance of the storm, although the definite rules for so doing need not now be given.

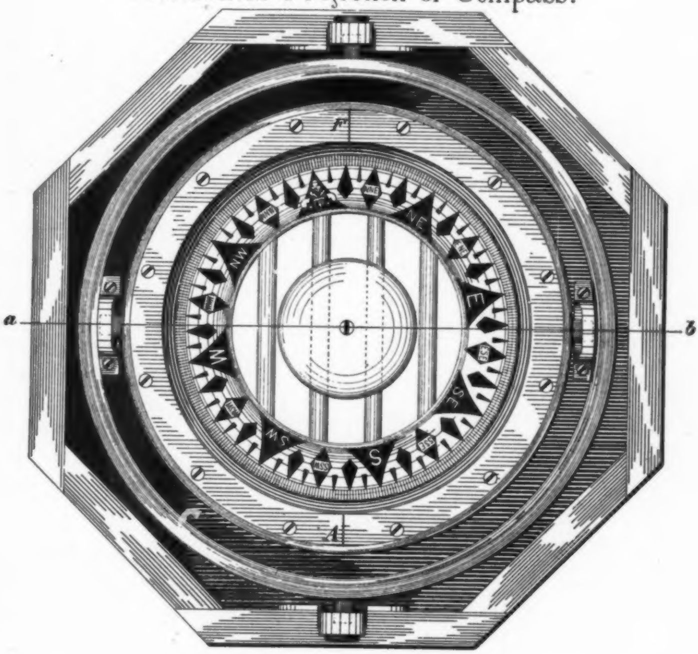
Assuming, therefore, that the storm centre bears at right angles to the direction of movement of lower clouds and is on one's right hand when he faces the direction from which these clouds are coming, it remains only to show how to use the nephoscope in order to obtain the direction of cloud movement.

The accompanying diagrams present both a horizontal projection and a vertical section of Ritchie's Patent Liquid Compass, as used on American naval vessels, as also a similar projection and vertical section of my marine nephoscope. The compass proper may be described as a heavy bowl mounted on gimbals and so adjusted as to its axis of gyration that its time

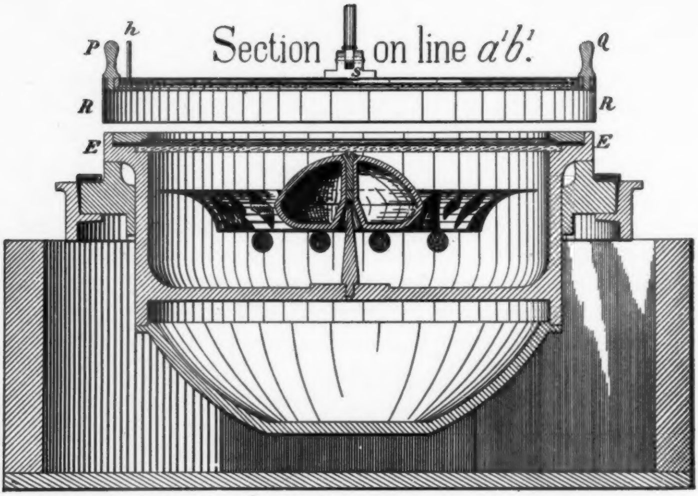
of vibration is rather long, namely, about one-half second. The lower half of the bowl is ballasted, and its upper half constitutes a closed receptacle full of liquid, bounded by the circular plate of glass. Within the liquid floats the compass card and needles; the compass card shows not only the thirty-two quarter points, but also every degree of azimuth. The observer looking down upon the plate-glass top sees the compass card, which is just below it, and also the lubber line, FA, as marked on the brass rim. As the vessel rolls or pitches the compass card preserves its horizontal position fairly well up to a limiting roll of about thirty degrees. In the standard compass of the United States Navy the upper edge or flange of the compass bowl, EE, is neatly turned to an exact circle concentric with the pivot and about nine and one half inches in diameter. This is for the purpose of setting thereon, at any moment, the alidade and sights for observing the sun and stars, or otherwise determining the true azimuth and the magnetic variations and deviations at any time. Ordinarily, this apparatus is not in place on the compass, and, therefore, without disturbing the regular work of the ship, we may set the nephoscope on the compass in place of the astronomical apparatus. The thin circular vertical flange of the nephoscope is shown in section RR, and it fits snugly over EE. The nephoscope consists essentially of this circular flange RR, whose upper horrizontal surface is the ring on which appear the graduations for every five degrees, numbered from 0 around to 360 in the direction in which azimuths are ordinarily measured. In order to revolve this ring horizontally, two small handles, PQ, are provided. Within the graduated ring the circular area is covered by a single plate of thin mirror glass of excellent quality, silvered on the lower side. But as it is necessary to look through at the compass card below, the silvering has been removed in a broad circular band; there is also a smaller circle of half its size, as shown by the heavy black line; the outer and inner boundaries of these circles are made quite exactly smooth and concentric with the centre of the small black spot C, which is immediately over the compass pivot.

When this silvered mirror is in place upon the compass it represents a horizontal plane, and it preserves its horizontality with remarkable persistence, notwithstanding the ordinary rolling and pitching of the vessel. In the absence of any convenient

Horizontal Projection of Compass.

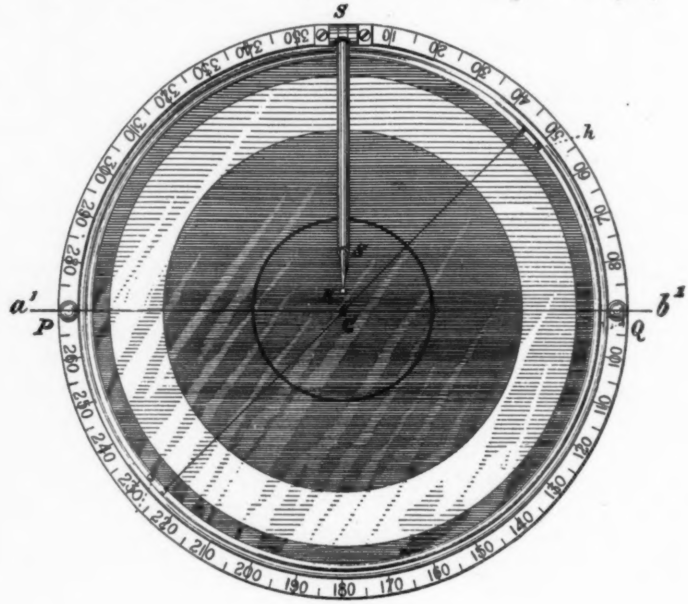


Section on line $a'b'$.



Section on line ab.

Horizontal Projection of Nephoscope.



method of exact measurement, I have been able only to estimate that, in the case of the compass used by me on board of the U. S. S. "Pensacola," the inclination of the mirror plane to the horizon was rarely more than two degrees, and to this extent, therefore, an uncertainty is introduced into all our measurements; but, as the inclination is perpetually oscillating from positive to negative, we have, therefore, only to take the average of a few observations in order to obtain results that are appreciably free from this source of error. The observer must, however, be careful to keep the compass in such adjustment that the bowl shall not have any constant error in this respect; of course this same adjustment is also necessary in connection with the observation of the sun or stars.

In so far as the mirror is horizontal, therefore, a line drawn perpendicular to it at its centre is an approximate realization of a standard vertical line on shipboard, and our object now is to determine the motion of the clouds with reference to the zenith and horizon of this mirror. When the observer looks into the mirror he sees reflected therein not only the masts and rigging and pennants, but the clouds, and even the sun, moon, and stars. The apparatus is a simple, crude, but convenient altitude and azimuth instrument, and with it we can perform all the operations of determining altitudes, latitude, time, longitude, and azimuth with a very surprising degree of accuracy. I have many times had occasion to set up this nephoscope on shore, and, besides observing the clouds, have determined the altitude and azimuth of the sun; the probable error of a single measured altitude of the sun or moon is about one quarter of a degree, and could be made still smaller by appropriate changes in the construction. In order to measure the apparent altitude and azimuth of clouds by a method sufficiently expeditious, simple, and accurate for use at sea I devised the hollow tube S S, and the sliding rod which fits within it with friction, and which carries at its end the small knob, K. The tube has a motion in a vertical plane about the hinge, S, and when elevated to any altitude is held there by the friction of this joint. The vertical plane through the tube, the knob, the central spot, C, and the hinge, S, corresponds with the zero of the graduation of the horizontal rim. The numbering of the degrees is from 0 to 360. The knob and the central spot, C, have the same diameter so

that in whatever position the knob may be placed (by elevating the tube and sliding the rod in or out) the observer can bring his eye to such a position that he will see the knob reflected in the mirror and exactly covering the spot. Let us suppose that the observer has done this and that he also sees reflected, at C, a small bit of cloud or a point in a large cloud; then if he continues to hold his eye in such a position that K always falls upon C the cloud will seem to move away from the centre of the mirror. But he may, if he choose, so move his eye that the image of the knob shall continually cover the selected point of cloud, and if he does this, then both cloud and knob will appear to move together away from the centre of the mirror. This latter is the method of observation that is always to be recommended, and if one could keep the cloud and knob together until their reflections simultaneously reach the edge of the graduated rim, he could then read on the rim an angle that represents the azimuthal direction of their motion relative to the zero of that circle. The position of this zero with reference to the lubber line, F A, of the vessel is given by taking from the same circle the reading corresponding to the forward end of the line, F; the relation of F to the magnetic meridian is given by taking from the compass card, as seen through the unsilvered glass, the angle corresponding to the same forward end of the line, A F; the relation of the magnetic to the true meridian is known from the tables of deviations and variations. These four angular readings, when added together, give the true azimuth of the apparent motion of the cloud.

Inasmuch as we do not often care to wait as long as is necessary for the image of the cloud and knob to move from the centre to the edge of the mirror, and especially since it continually happens that the cloud disappears or becomes unrecognizable in the midst of an observation, it is necessary to provide for that class of observations which really occurs most frequently, namely, where the cloud is followed only out to the first small circle whose radius in the present apparatus is exactly one inch; I have, therefore, provided a black copper wire or silk thread that stretches entirely across the circular mirror and is attached to a rather heavy wire forming a circle adjacent to the inner edge of the rim. As this circle with its wire must be easily turned in azimuth, there are provided two small handles, *h* and *h*; by

taking hold of these the observer easily brings the thread into such a position that both cloud and knob traverse it together as they move across the mirror, and no matter how short their path may be, the azimuth of their motion is easily read at the end of the thread. We thus provide all that is necessary in order to obtain either the true or the magnetic bearing of the movement of the cloud. It is easy to see how one may utilize the same thread to determine the azimuthal trend of the trail of smoke which a steamer leaves in its wake, or the trend of the streamers and pennants seen reflected in the mirror, and, as all these depend upon the combined motion of the wind and vessel, they have been subjects of regular observation by myself on the U. S. S. "Pensacola." Moreover, when one wishes to observe the trend of the troughs and ridges of waves, or of the foam that flecks the water with white streaks during high winds, he has here an apparatus more convenient and accurate than the estimates of any but the most skilful navigators, as I can testify from considerable personal experience. Not only the motions of the clouds, but general trend, or the vanishing points of special formations in the cirrus clouds, the boundaries of cloud rolls, the location of the zodiacal light, and the dimensions of halos and rainbows, are easily determined.

By determining the apparent angular altitude and the apparent velocity per second of the cloud under observation, when a vessel is going at different speeds and in different directions, we may compute the actual velocity and height of the cloud. But I will not here enter upon a complete account of the many problems that can be solved with the help of this simple apparatus ; they are mostly questions that interest the meteorologist rather than the navigator. The latter needs the nephoscope mostly in order to determine the true direction of motion of the clouds, and for this purpose, if his vessel is a steamer, he first observes the apparent direction of motion as seen in the nephoscope when going ahead at his ordinary speed ; he then slows up a little for five minutes and takes another observation and, if he can, slows up for another five minutes and after getting a third observation resumes his full speed and takes a final observation. The difference between the results obtained at high speed and low speed enables him to easily find what the true direction of the cloud motion is or as it would be observed if the vessel were

stationary. If the navigator is on a sailing vessel it is easier for him to observe on two different tacks, and the comparisons of the results thus obtained will give him the true motion of the clouds. When the wind has a strength above force 6 on the Beaufort scale, the movements of the lower clouds are apt to be so much more rapid than those of any sailing vessel that the cloud movement is given with sufficient approximation by single observations without the necessity of combining those made on different tacks. Convenient numerical tables will be published in a "Manual of the Nephoscope."

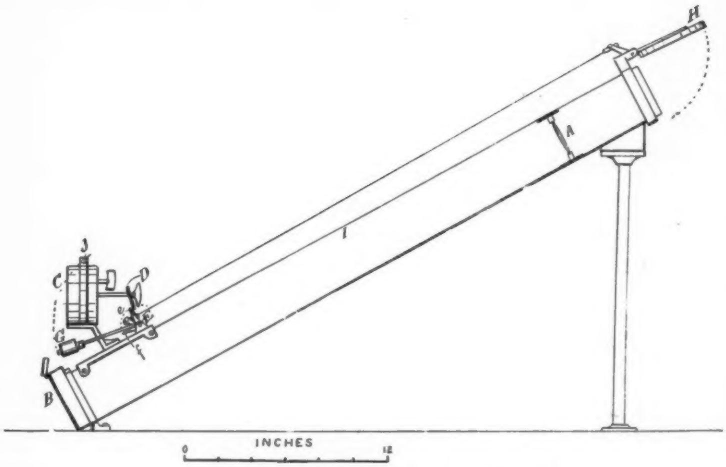
THE POLE STAR RECORDER.

S. P. FERGUSSON.

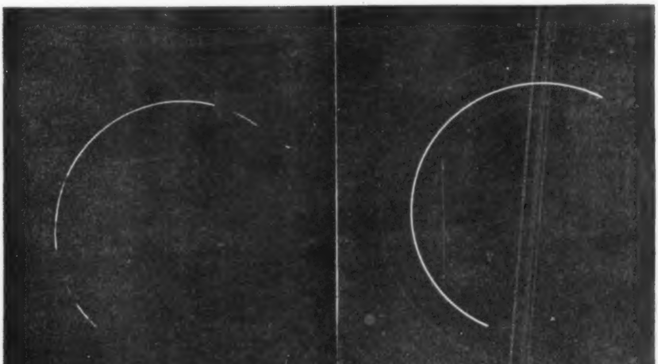
THERE has been designed but one practical instrument for recording cloudiness at night, and while this has been in use at a few observatories for several years, its principle and details of construction are not very well known.

The principle is that of a camera suitably arranged for photographing the pole star continuously during the night and provided with automatic devices for opening or closing the shutter. The pole star is not located at the true pole but at a distance of about 1.3° from it. Consequently during a complete rotation of the earth the star will apparently describe a circle the radius of which will be 1.3°. If a camera is exposed continuously to the sky at the pole during the night this motion or trail will be photographed in the form of an arc of a circle the length and radius of which will depend respectively, upon the duration of exposure and the focal length of the camera. This arc will be continuous if the sky near the pole remained clear during the exposure, and broken if the star was obscured by clouds at any time. By reading the arc with a suitable scale the variations of cloudiness during the night may be easily and quite accurately obtained.

The Pole Star Recorder, invented in 1886 by Prof. E. C. Pickering consists of a lens A of about 30 inches focal length mounted in a tube I which is provided with a hinged shutter H at one end and a plate holder B at the other. An alarm clock C serves to open or close the shutter at any desired time. The



THE PICKERING POLE STAR RECORDER.



RECORDS MADE BY THE POLE STAR RECORDER.

shutter is connected by means of a wire with the arms *e* and *f* which are pivoted at E. To the alarm key of the clock, which is made longer than usual, is secured a flat strip D which, as the clock is wound, may be so placed as to intercept either of the arms *e* or *f* until they are automatically released. When the weight G is clamped to the axis E, and the arm *f* is released, the weight of G causes the shutter to open, and when G is removed and *e* is released the shutter drops by its own weight. It is necessary to reset the alarm and levers when changing the mechanism after opening the shutter in order that the clock may close it and *vice versa.* Should the clock become unserviceable it may be removed, by loosing the clamp J which secures it in position, and replaced by a new one. The keys are interchangeable and the long alarm key may be unscrewed from the old and attached to the new clock, the entire operation of changing clocks, etc., requiring but a few minutes. There are several other serviceable devices for opening and closing the shutter, among which that of using two clocks, one for each operation, is useful in that it requires setting but once daily.

Ordinary photographic plates of sensitometer 23 to 26 and 3¼ by 4¼ inches in size may be used, and the exposure is usually made to begin an hour after sunset and end an hour before sunrise. The time of exposure, to the nearest whole hours, for the vicinity of latitude 40° is, for January and February, 6 P. M. to 6 A. M.; March, 7 P. M. to 5 A. M.; April, 8 P. M. to 4 A. M.; May, June, and July, 8 P. M. to 3 A. M.; August, 8 P. M. to 4 A. M.; September, 7 P. M. to 4 A. M.; October, 6 P. M. to 5 A. M.; November, 6 P. M. to 6 A. M.; December, 5 P. M. to 6 A. M. The usual methods of caring for and developing the negatives may be followed with success. For future identification of the negatives the date, time of exposure, and whether the sky near the pole star is clear or cloudy at the beginning of exposure are written upon each plate before exposure, and the plate is always placed in the holder in the same position, usually with the date at the top. A reproduction of two records is given herewith. The broken curve was recorded on a partly cloudy night and the complete curve on a clear night. The arc described by the star is of about 0.7 inch radius and may be read by means of a circular transparent scale of 24 divisions corresponding to hours of time. The records are more accurate in some respects than

those of a sunshine recorder as always the same portion of the sky at an average elevation above the horizon is photographed. The cost of the instrument is less than that of the best sunshine recorders and probably does not exceed $25. The cost of a year's supply of photographic plates is about $15 to which should be added the cost of developing which may amount to $5 more, for each year.

It would be very desirable if a large number of these instruments could be placed in operation in different parts of the country as the few records of cloudiness at night that exist have been maintained only at much expense by special observers.

Blue Hill Observatory, March 20, 1894.

CURRENT NOTES.

The Cyclones of the Southern Pacific Ocean. — Dr. E. Knipping, formerly Director of the Meteorological Observatory at Tokio, Japan, has recently published, in the *Archiv der deutschen Seewarte* (XVI. Jahrgang, 1893), a valuable article on the "Tropical Cyclones of the Southern Ocean between Australia and the Paumotu Islands."

The great expanse of water between Australia and South America naturally divides itself into two parts, the eastern of which is almost free of islands, while the western has a great number of islands, singly and in groups. During the winter of the southern hemisphere the southeast trade prevails over the whole region from Australia to South America, but in the southern summer a northwest monsoon blows over the eastern part of this ocean, from north Australia and New Guinea as far as the Banks Islands and occasionally also reaches the New Hebrides, south of the Banks Islands. Further to the east, in the region in which lie almost all the other important islands situated south of the equator, as far as the Paumotu Islands, the southeast trade is irregular. Northeast and northwest winds alternate with southeast winds and calms. This interference with the regular development of the southeast trade is due to the presence of these islands. The broad, dry areas of North Australia, rapidly warmed under the strong insolation as the sun approaches the tropic in November and December, are the first cause of the northwest monsoon. They become regions of low pressure, in consequence of their high temperature, and an inflow of air from the north results. A similar effect is seen in the case of the large islands to the east, as far as the New Hebrides, and over all this district the regular southeast trade of these latitudes is interfered with. As the sun moves north, crossing the equator in March, the southeast trade gradually moves over the area recently occupied by the monsoon, until, in April or May, it again prevails here. During the prevalence of the northwest monsoon there is much rain over all the region it covers, owing to the high temperatures of water and land, the great quantity of water vapor in the atmosphere, and the favorable conditions for convectional air currents. The most striking difference between the eastern and western divisions of this great Southern Pacific area is, however, the fact that in the former cyclones are unknown, while in the latter one or more occur every year. The occurrence of these cyclones and the prevalence of the northwest monsoon are referred to the presence of the islands in the western part of the ocean.

Dr. Knipping has carefully examined the records for this region and finds in all 125 cyclones noted. Of these, 109 occurred in the months December to March, 12 in April and November, and 4 in September, October, and

May. They come most frequently between the middle of December and the end of March, though they occasionally occur as early as September and as late as May. The majority of these cyclones, 104, were first noted on the principal groups of islands, New Caledonia, New Hebrides, Fiji, and Tonga; the remaining ones, 21 in all, were distributed, in decreasing numbers, between northeastern Australia, the Salomon, Friendly, Cook, and Paumotu Islands. An examination of a chart showing the frequency of these cyclones over five-degree squares reveals the fact that there are more of them around the larger groups of islands, and that they decrease in number as the distance from these land areas increases. A chart of cyclonic tracks shows that the prevailing direction of movement is southeast, next south and then southwest. Of 55 charted tracks, 32 are straight, 22 have the usual parabolic curve, open towards the east, and one is irregular. The cyclones that move southwest in the ocean area, northeast of Australia, curve to the southeast near the Australian coast. South of a line joining southern New Caledonia, Southern Fiji, Tongatabu and Upolu, the direction is almost without exception to the southeast, while north of this line the directions south and southwest also occur. The maximum of cyclonic frequency is found to be dependent on latitude. The Samoan and Fiji Islands, lying respectively in latitude 14° and 16°–18° S., are crossed by the vertical rays of the sun twice each year, while New Caledonia, in Lat. 20°–23° S., lies almost directly on the tropic. It is found that New Caledonia has only one maximum of cyclonic frequency, while the Samoan Islands have two maxima, separated by a minimum. It is to be expected, also, that the total number of cyclones should be greater at New Caledonia than at the Fiji Islands, and greater at the Fiji Islands than at the Samoan Islands. There are not sufficient data yet at hand to establish this as a fact, but the general belief of seafaring men in that region is in support of this expectation.

The average velocity of these cyclones is 8 nautical miles an hour. The maxima noted are 18, 16, and 15 nautical miles. The pressure does not fall exceptionally in many cyclones. Pressures of 710, 712, and 713 mm. (27.95, 28.03, 28.07 in.) have been noted near New Caledonia; 700, 705, and 720 mm. (27.55, 27.75, 28.34 in.) near the Fiji Islands, and 687 mm. at Apia (27.05 in.). The latter reading was taken on the "Favorite" in the harbor of Apia, April 6, 1850. The duration of the cyclones varies from several days to a few hours, and depends principally upon whether the observer is in the neighborhood of the islands or south of them. The longest duration, six days, is reported for cyclones in the region between New Caledonia and the New Hebrides. The average breadth of the cyclones is about 300 to 400 nautical miles; it is seldom under 200 or over 800 miles. These storms are occasionally accompanied by a storm-wave, which does great damage to shipping and to villages near the coast. The duration of the central calm, or "eye," seems to vary greatly. In one case it was ten minutes; in another eleven and one half hours. The diameter of the "eye" is usually less than 30 nautical miles.

The main facts with regard to these storms may be summarized as follows: the real season of cyclones lasts from the middle of December to

the end of March. March has the most frequent and most severe cyclones, New Caledonia being an exception to this, for its maximum comes in January and February. Most of the cyclones are reported in the triangle formed by the New Caledonia, Samoan and Cook Islands, and south of it. None have yet been reported between the equator and latitude 9° south. Every heavy rain of long duration may give rise to a cyclone. During the period of formation, which may last several days, the air currents blow towards the centre with little deflection; and wind, clouds, and sea give less warning than barometer and rain. Islands favor the development of cyclones, while continents, like Australia, favor their disintegration.

Dr. Knipping's paper is illustrated with charts showing the distribution of cyclones in five degree squares; the cyclonic tracks of the Southern Pacific, and the courses and barometer readings of several vessels which passed near or across the path of a cyclone.

The Names of the Winds. — In the "Deutsche Rundschau für Geographie und Statistik," Vol. XVI., No. 3, Dr. Friedrich Umlauft has an article on "The Names of the Winds," which has been reprinted in the January number of the *Meteorologische Zeitschrift.* It has always been customary to name the winds according to the points of the compass from which they blow, and also according to the region from which they blow. So winds blowing from land to sea are called land-winds, those from off-shore to the land, sea-winds. English and Americans call these winds land and sea breezes; Germans call them *landwinde* and *seewinde;* the French, *vent de terre* and *vent de mer.* The day and night breezes noted in mountain regions are generally called mountain and valley winds. In some places, on lakes (as for instance on the Lake of Garda), these winds are termed respectively lower wind and upper wind, according to their origin at the lower or upper end of the lake. On the Lake of Garda the upper wind is called *Sopero,* from the Italian *sopra.* In the Taunus mountains the wind blowing down from the ridge (*Joch*) of the mountains is called *Jochwind;* on the Lakes of Garda and Maggiore the mountain wind is known as *Tramontana;* on the Lake of Geneva the wind coming down from the Vaud country is known as *Vaudaire;* in the Rhine valley the breeze blowing out from the Wisp valley is called *Wisperwind.* In eastern lower Austria the wind which blows from Hungary is called the *Hungarian* wind. The Italians call their northeast wind *Greco,* the Greek. On the western coast of Malacca the stormy winds blowing from the Island of Sumatra are called Sumatrans. In Argentina the winds from the Pampas are known as *Pamperos.* The Romans called the southwest wind *Africus,* and the Italians call it *Affrico* to-day. The Greeks called their winds Boreas, Skeiron, Olympias, etc., according to the regions from which they came.

Homer names four winds only: Boreas, Zephyros, Euros, and Notos. Boreas was the north wind coming from the mountains in northern Greece; Zephyros was so named from the word meaning darkness, or evening, and was the west wind; Euros indicates light, and means a wind from the East; Notos is derived from the word *notios,* wet, damp, and means a wind that brings rain, — a south wind in Greece. The Greeks afterwards increased

the number of their wind names by the addition of four new names, to distinguish northeast, southeast, northwest and southwest winds, and later added four more, so that they had twelve in all. Of these eight original names, two were derived from the light quarter of sunrise; one from the dark quarter of sunset; four referred to the kind of weather that the winds brought, and one to the mountainous region of northern Greece from which it came. The four new names were in three cases taken from the countries from which the winds blow.

The Romans called the four principal winds Auster (south), Septentrio (north), Favonius (west), and Vulturnus (east), and later, added Solanus, Aquilo, Africus, and Corus. The Greek names (Eurus, Zephyrus, etc.) were later adopted. Auster was derived from a word meaning shine, and refers to the light quarter; Favonius, from *favere*, to be favorable to, was the name given to the favorable west wind; Vulturnus, from *vellere*, *vulsi*, meaning a stormy wind; Solanus, from *sol*, meaning an east wind; Aquilo, from *aquilus*, dark, meaning a rainy weather wind; Africus was derived from Africa, and Corus from a word meaning to cover, conceal, because the northwest wind brought clouds.

The four cardinal compass points, north, east, south and west, are very similar in English, French and German. East comes from *austa*, Sanskrit *vas*, shine, and is therefore closely related to the Greek Euros and Latin Auster, designating the light-bringing quarter of the sky, and the wind that comes from there. West is derived from the Gothic *vis*, peace, calm, and refers to the quarter of the sky that brings sunset and rest. North probably comes from Gothic *vairan*, to be wet or fluid, to which the Greek *naros*, fluid, wet, is related, and carries the idea of darkness. South seems to have come from the Gothic *sunnô*, old high German *sunna*, sun.

Local winds are generally named by the Germans according to the weather or temperature which they bring. In the neighborhood of Innsbruck the warm southerly wind, blowing down from the Brenner, is called "warmer wind." In Switzerland and in the Tyrol the warm wind which, in springtime, melts the snow and makes the ground *aper*, free of snow, is known as *Aperwind*. *Bise* is the name commonly given by the Swiss to the dry and cold north wind, which is also called *Bis* or *Beiss* wind, on account of its harsh, biting quality. *Foehn* probably comes from the Latin Favonius.

In Italy, *Sirocco* probably comes from Syriacus, Syricus, Syrian wind. *Maestro*, master wind, is the name given to the northwest wind, which prevails over the Adriatic, principally in summer, and is a fine weather wind. In France the word becomes *Mistral*, and is a destructive wind.

It has been seen, from the foregoing, that the original names of the east and west points of the compass and of the winds from those points, were derived from words connected with the appearance and disappearance of daylight; the names of north and south were principally associated with the kinds of weather that came from those points. Other names for the winds are associated with certain definite characteristics of the different winds. A well-known characteristic of land and sea breezes is the change in direction of the wind from off-shore at night to onshore during the day, and back again at night, combined with the veering (in this hemisphere) due to the

earth's rotation. These winds are called "roundabouts" on the coast of New England. The Greeks recognized this quality and called sea breezes *Tropaioi*, from *trepo*, to turn. In the district about the La Plata the regular land and sea breezes are called *Virazones, i. e.*, turning winds. The sea breeze on the lower Congo is called *Viraçao*, which has the same meaning. *Solaures* (solis, aura), sun winds, is the name given to the diurnal winds in the Department of the Drôme. *Panga Mbili* (two sails) is the name given to the period of varying winds between the two monsoon periods on the coast of Zanzibar. The monsoons themselves are named from the Arabic *mausim*, meaning seasonal. The *Chamsin* of Egypt means fifty, so called, it is said, because it most frequently occurs, according to ancient Coptic calendar reckoning, in the fifty days between Easter and Whitsunday.

Winds are further named according to their influences and effects, for good or evil. Such names are the *Maestro*, the *Bise*, etc. In Russia the violent northerly snowstorms are called *Metél*, broom, because they sweep over the ground. "Sick winds" are the southerly and southwesterly winds which are prevalent on the Sandwich Islands from December to February, and which cause much sickness. The word *Samun*, or *Samoom*, given to the burning destructive desert wind of Arabia, is derived from the Arabic word *ssim*, poison. In the Tropics the cooling, health-giving sea breeze is called the "Doctor" by the English residents along the coasts, for without it life would there be unbearable.

Antarctic Exploration. — The February number of the *Scottish Geographical Magazine* contains two interesting articles on Antarctic Exploration. The first is by Mr. William S. Bruce, and is entitled "The Story of the Antarctic"; the second is by Dr. C. W. Donald, and bears the title, "The Late Expedition to the Antarctic." Mr. Bruce gives a brief account of the history of South Polar exploration, which began with an expedition sent from Peru in 1567, this being followed by a second one in 1605. In 1598, Dirk Gerrits set sail from Amsterdam, and discovered the South Shetlands. Other expeditions were sent by France in 1675 and 1772. Captain Cook first crossed the Antarctic Circle in 1773. There were several other expeditions, English, Russian, and American, but the most famous was that of Ross, with the "Erebus" and "Terror," in 1839–43, that explorer having reached latitude 78° S. In 1892–93, Scotland despatched a whaling fleet, to which was attached a scientific staff, to cruise in the Antarctic, and Mr. Bruce and Dr. Donald accompanied this fleet. The notes on the climate of the South Polar regions are, of course, particularly interesting to meteorologists, and from Mr. Bruce's account we quote the following: —

"Like our predecessors, we found it to be a region of gales and calms, — gales from the north, with wet fog; gales from the south, with blinding snow; calms with fog, and calms with brilliant sunshine. Towards the middle of December, when we were approaching the icy regions, we lay-to in squally weather and thick fogs. Gradually we pushed southward, and soon entered latitudes where flat-topped icebergs surrounded us on every side, and where pack-ice floated on the water. Squally weather continued until the 24th of December, when, in the vicinity of the Danger Islets, we

met with a great number of bergs. From the deck I counted as many as sixty-five at one time, many being one to four miles in length, and about one hundred and fifty feet in height. Long shall I remember this Christmas Eve, when we were fast anchored to a floe. There was a perfect calm; the sky, except at the horizon, had a dense canopy of cumulus clouds, which rested on the summits of the western hills; and when the sun was just below the horizon, the soft grays and blues of the clouds and the spotless whiteness of the ice as it floated in the black and glassy sea, were tinted with the most delicate of colors — rich purples and rosy hues, blues, and greens, passing into translucent yellows. At midnight the solitude was grand and impressive, perhaps the more so since we had for well nigh a week been drifting among bergs, with dense fogs and very squally weather. No sound disturbed the silence; at times a flock of the beautiful sheath-bills would hover around the vessel, fanning the limpid air with their soundless wings of creamy whiteness. All was in such unison, all in such perfect harmony; but it was a passing charm. Soon we had to think of more prosaic things, and reluctantly we turned our thoughts to the cargo we were to seek.

"This is the picture of a calm midnight in mid-summer; different, indeed, from the heavy weather we experienced at other times, when for days we sheltered behind bergs and streams of pack, during black nights, thick with fog or snow. One of the gales we encountered, the skipper described as the hardest that ever blew in the Arctic or Antarctic; and, indeed, it was stiff. For ten hours we steamed as hard as we could against it, and at the end only had made one knot. Picture to yourselves a sailing vessel: what a different agency we have now! Where Cook, Ross, Weddell, and others would have been in the greatest peril, we, with steam, were comparatively safe.

"The records of air temperature are very remarkable; our lowest temperature was 20.8° Fahr., our highest 37.6° Fahr., — only a difference of 16.8° Fahr. in the total range for a period extending slightly over two months. Compare this with our climate, where in a single day and night you may get a variation of more than twice that amount.

"During the last five months, in London, I have experienced temperatures ten degrees higher than on either of our crossings of the Equator, and five degrees lower than our lowest recorded temperature in the Antarctic.

"The average temperatures show a still more remarkable uniformity. December averaged 31.14° Fahr. for one hundred and fifteen readings; January, 31.10° Fahr. for one hundred and ninety-eight readings; February, 29.65° for one hundred and sixteen readings — a range of less than 1½° Fahr. This seems worthy of the special attention of future Antarctic explorers, for may it not indicate a similar uniformity of temperature throughout the year? Antarctic cold has been dreaded by some; the four hundred and twenty-nine readings I took during December, January and February show an average temperature of only 30.76° Fahr.; and this was in the very height of summer, in latitudes corresponding to that of the Faroe Islands in the North, but I believe the temperature of winter does not vary much from that of the summer as in the North.

. . ."I have told you somewhat of the Antarctic in summer; what the winter is no one knows. You will see that in the South we have a very different country to deal with as compared with the North. The conformation of land and water is exactly the reverse. In the North we have water surrounded by land—a polar basin; in the South, land surrounded by water—a polar continent."

Dr. Donald's article deals with the fauna and flora of the regions visited by the Scotch whalers. Concerning the fogs he says:—

"A sketch of the Antarctic would scarcely be complete without mentioning its fogs. These are frequent enough and dense enough to be troublesome. Yet they have a peculiar beauty of their own. In the morning, as a bright sun begins to dispel the fog, there first appears a 'fog-bow,' or, as the sailors call it, a 'fog-schaffer,' or 'scavenger,' their belief being that this bow eats up or removes the fog. It is in the form of a perfect circle, the two ends appearing to meet beneath one's feet. Soon after this luminous points appear in the fog, and gradually extend into patches; I have counted as many as twenty of these. As the fog lifts a little more, each of these patches is seen to be suspended immediately above an iceberg. Then the fog finally disperses with a rush, leaving a bright sun and a cloudless sky, and every promise of a magnificent Antarctic day. Many of the fogs, however, do not disperse in this accommodating way, and may last for days."

The prevailing winds in the regions visited by Mr. Bruce and Dr. Donald were south, southeast, and east.

*The late Thomas George Hodgkins.** —Thomas George Hodgkins was born in England in 1803, and his early boyhood was spent there. When about seventeen years of age, led by a youth's love of adventure, as well as by the desire to aid his family, then in somewhat reduced circumstances, he shipped on one of the East India Company's vessels, and made a voyage to the farther East, where he narrowly escaped death by shipwreck. Consequent upon this misadventure, came confinement in a hospital in Calcutta for some months. During this period of enforced quiet and physical inaction, he formed the resolve that his life, if spared, should henceforth be devoted to advancing the welfare of his fellowmen.

After recovery he returned to England, where he married. A few years later he came to the United States, and in 1830 established himself as a manufacturer in New York city. Such success attended his business ventures that in 1859 he withdrew from active pursuits and returned to Europe, where he travelled for some years. His heart, however, led him again to this country, which he had chosen as the home of his early manhood, and which he now made the abiding place of his mature years. In 1873 he bought a country place near the village of Setauket, on Long Island, which he named "Brambletye Farm," and which became his home for the remainder of his life.

Those who had the privilege of a personal acquaintance with Mr. Hodgkins saw in him not only a man of unusual judgment in business affairs, of

*From the Report of the Secretary of the Smithsonian Institution, June 30, 1893.

broad and far-reaching philanthropy, and of deep sincerity in his purpose to benefit his fellow-creatures, but they were struck by the breadth of his views as expressed in connection with subjects generally held to pertain more exclusively to purely scientific research, every domain of which he gladly sought to make contributory to his earnest desire to benefit mankind.

His life was simple and his wants but few, and requiring only a small portion of the products of the home farm for his own use, he pursued his long-established habit of systematic benevolence by giving the remainder to those around him.

Fulfilling also the purpose formed long years before, to further the good of mankind by all means at his command, he devoted the greater part of his large fortune to various benevolent objects, reserving but a comparatively small sum for his own support.

His sympathy for the helpless and weak led him to contribute largely to the American Society for the Prevention of Cruelty to Children, and to the American Society for the Prevention of Cruelty to Animals. He gave $100,000 to the Royal Institution of Great Britain, and $200,000 to the Smithsonian Institution, stipulating that while the latter sum should be included with the original Smithson Foundation, that the income from one half of it should be devoted to researches and investigations on atmospheric air in connection with the welfare of man.

The death of Mr. Hodgkins occurred at his home in Setauket on the 25th of November, 1892. Those whose duty it is to carry out the plans and to administer the trust laid upon them by the bequest of this man, who so simply and earnestly determined to make the world better by his life, are glad to know that he had the satisfaction of living to see and to approve the initiatory steps taken in administering the Hodgkins fund of the Smithsonian Institution. A biography of him, in some respects fuller and more personal, will be found in the minutes of the Board of Regents for the present year.

Royal Meteorological Society. — The monthly meeting of this Society was held on Wednesday evening, March 21, at the Institution of Civil Engineers, Westminster; Mr. R. Inwards, F. R. A. S., President, in the chair.

Mr. H. C. Kiddle and Mr. S. R. Lowcock, Assoc. M. Inst. C. E., were elected Fellows of the Society.

Mr. W. H. Dines read a paper on the "Relation between the Mean Quarterly Temperature and the Death Rate." The Registrar General's Quarterly Returns for the whole of England since 1862 were taken by the author, and the number of deaths in each quarter expressed as a departure per thousand from that particular quarter's average; the value so obtained being placed side by side with the corresponding departure of the temperature at Greenwich from its mean value. The rule seems to be that a cold winter is unhealthy and a mild winter healthy; and that a hot summer is always unhealthy and a cold summer healthy.

Mr. Dines also read a paper on the "Duration and Lateral Extent of Gusts of Wind, and the Measurement of their Intensity." From observations and experiments which he has made with his new anemometer, Mr. Dines is

inclined to think that a gust seldom maintains its full force for more than one or two seconds; and also that the extreme velocity mostly occurs in lines which are roughly parallel to the direction of the wind.

Mr. R. H. Scott, F. R. S., exhibited a diagram showing some remarkable sudden changes of the barometer in the Hebrides on Feb. 23, 1894. At 8 A. M. the reading at Stornoway was 29.39 in., being a fall of 0.7 in. since the previous day, and at 6 P. M. the reading was 28.58 in. From the trace of the self-recording aneroid it appears that the minimum, 28.50 in., occurred about 5.30 P. M., and that the fall during the half hour preceding the minimum was nearly 0.2 in., the rise after the minimum being nearly as rapid.

The other paper read was: "On the Calculation of Photographic Cloud Measurements," by Dr. K. G. Ilsson.

A New Method of Estimating Cloudiness. — In the October number of *Das Wetter*, 1893, Dr. C. Kassner gives an interesting description of a new method of estimating cloudiness. He points out that the apparent vault of the sky is not a perfect half sphere but is flattened, and when one points his finger at the part of the sky which appears to be midway between the zenith and horizon his arm is inclined at an angle of only 22° above the horizon. Consequently, the same amount of cloud is estimated differently at different angles above the horizon. Theoretically the same amount of cloud would be less when near the horizon, but in this connection he did not consider the effect of the vertical thickness of the clouds which plays an important role in making the apparent amount of the clouds greater when near the horizon, and is especially striking in the case of cumulus clouds. He suggests that the amount of clouds estimated by means of photographs taken with the camera pointing vertically would eliminate this error, as well as several others which he describes. As simple methods of eliminating these errors he describes several devices for determining the true angle of 45° from the zenith, and recommends the estimation of the amount of cloudiness in this zone in each of the quadrants, north, south, east, and west, and dividing the sums by four. At Dr. Kassner's suggestion, Herr Schlottman carried out a series of measurements by one of these latter methods in connection with estimates by the old method. Dr. Kassner presents a study of his results in detail. The two most interesting tables are here given. In the first he shows how much the estimates by the new method differed from the old with different degrees of cloudiness. The amount of cloudiness in tenths of the whole sky by the old method is shown by the vertical scale and the number of times the new method differed from the old, none, one, two, etc., tenths, is shown by the horizontal numbers: —

Old Method.	New Method.					
	+2	+1	0	−1	−2	−3
0 — 1	0	0	37	17	0	0
2 — 3	0	3	20	16	1	0
4 — 6	1	8	15	17	5	0
7 — 8	0	15	34	16	3	1
9 — 10	0	40	34	4	0	0

It is seen that in most cases the new method agreed with the old though in some cases it differed from it as much as three tenths of the whole sky. When the new method differed from the old it was generally one tenth less in the smaller cloud amounts and one tenth more in the larger. The following table gives an abstract of the comparison for the different kinds of clouds: —

Cloud form.	+2	+1	0	−1	−2	−3
Cirrus	0	0	3	3	0	0
Cirro-stratus	0	0	6	2	1	0
Alto-cumulus	0	3	15	6	0	1
Alto-stratus	0	5	12	6		
Strato-cumulus	0	20	10	1	1	0
Cumulus	1	4	21	12	3	0
Sum of highest clouds	0	17	112	63	6	2
Sum of lowest clouds	2	81	73	35	9	0

It is seen that with the sheet clouds (cirro-stratus and alto-stratus) the amounts varied nearly the same on each side of zero, but with the detached or broken clouds (cirrus and cumulus) the estimates of one tenth less were much more common than one tenth more. The striking excess of the +1 estimates in the strato-cumulus was perhaps because this cloud most frequently covers eight or nine tenths of the sky. (See preceding table.) It is seen by the latter part of the table that the highest clouds are more frequently overestimated by the old method as compared with the new, and the lower clouds are more frequently underestimated.

The method of confining the estimates of the amount of cloudiness within 45° of the zenith is not entirely new as it is recommended by Buchan in his text book, and perhaps by others. The writer was also under the impression that instrumental methods were used in Russia by Wild for determining the exact amount of the sky within given zones. H. H. C.

Seven-Day Thunderstorm Periods. — In this JOURNAL for July, 1893, pages 145–6, and for February, 1894, page 443, there were published notes on seven-day thunderstorm periods observed by Dr. C. Kassner in Berlin and by Dr. Polis at Aix-la-Chapelle. In the February number of *Das Wetter* Dr. Kassner has a further contribution to this subject, entitled "The Thunderstorms of Tilsit."

Meteorological observations have been regularly made at Tilsit since 1819, and from a compilation of the data as to thunderstorm occurrence during the years 1820–1890 it appears that July has had the greatest number of these storms. The number of thunderstorms has been increasing of late years, as the following table shows: —

1821–30	121	Thunderstorms.
1831–40	121	"
1841–50	161	"
1851–60	153	"
1861–70	119	"
1871–80	176	"
1881–90	218	"

This increase has also been noted at other places. A comparison of the years of maximum occurrence of thunderstorms with the years of sunspot maxima shows that the former usually come from one to three years after the latter, as appears from the following table:—

Years of maximum thunderstorm occurrence	1820	1828	1839	1850	1862	1873	1885
Years of sunspot maxima . .	1816	1830	1837	1848	1860	1870	1884

In regard to the weekly periodicity it appears that the maximum falls on Wednesday and Thursday, and the minimum on Friday. In this respect Tilsit differs from Berlin and Aix-la-Chappelle, and this difference Dr. Kassner believes to be due to the fact that the two last-named cities are great industrial centres, where there are many factories and much smoke, while Tilsit has but little variation in the amount of smoke in its atmosphere from day to day, as there are but few factories. A comparison of these three places in regard to the occurrence of thunderstorms on different days of the week is interesting. The subjoined table gives the percentage of thunderstorms occurring on each day of the week at Berlin, Aix-la-Chapelle, and Tilsit:—

	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Sunday.
Tilsit, 1861–'90	14.9	14.9	**15.8**	14.3	12.5	13.3	14.5
Berlin, 1861–'90	12.7	14.0	15.0	16.0	13.0	**17.3**	12.0
Aix-la-Chapelle, 1861–'90	17.2	12.7	13.7	13.0	13.1	16.6	13.7
Tilsit, (1821–'90)	14.6	14.2	15.4	**15.5**	**13.1**	13.7	13.6
Berlin, (1830–'40, 1848–'92)	13.3	15.2	14.4	14.3	13.3	**16.7**	12.7
Aix-la-Chapelle (1833–'52, 1858–'90) . . .	**15.3**	13.9	15.2	14.5	12.7	14.9	13.5

In each case Friday has few thunderstorms, while there is an increase on Saturday. Dr. Kassner concludes, as the result of his investigations, as follows: In places with many industries Saturday seems to have a preponderance of thunderstorms, while Sunday seems to have a minimum. In the latter case there may be a connection between the minimum of thunderstorm occurrence and the small number of factories at work on Sunday.

Weather Bureau Notes.—The results of the competitive examination for a professorship in the Weather Bureau, of which announcement was made in the October Journal, pages 290, 291, have been given out.

The percentages attained by the different candidates on Waldo's *Modern Meteorology*, on the Essay on Forecasting and on their general standing are as follows:—

Names.	Waldo.	Essay.	General Standing.
W. H. Hammon	10.3	10.4	76.3
W. L. Moore	9.3	10.8	
Park Morrill	10.6	10.4	75.9
H. C. Frankenfield	10.2	10.0	75.5
H. J. Cox	10.2	9.4	75.3
Alexander McAdie	11.4	10.3	73.1
I. M. Cline	9.8	9.6	72.8
Everett Hayden	10.5	9.4	72.3
E. B. Garriott	9.8	8.8	71.9
M. F. Godfrey	9.9	9.0	70.9

The Secretary of Agriculture has given directions to Mr. Alexander McAdie, of the Weather Bureau in Washington, to take up the question of Lightning. Mr. McAdie will prepare a pamphlet of about twenty-four pages, well illustrated, giving the latest information as to the best methods of protection from lightning. He will also undertake some experimental work.

The subject is one of great importance. On an average two hundred lives are lost annually in this country through this cause, and in 1892 over two million dollars' worth of damage was done by lightning.

The Harvard College Meteorological Stations in Peru. — The following extract is taken from a recent letter (dated Feb. 24) to the Editor of this Journal from Prof. S. I. Bailey, in charge of the Harvard College Observatory at Arequipa, Peru.

"We are hoping to start a station, within a few months, beyond the Andes to the east. This, in connection with the others, will give us a line of stations reaching across the Andes from the sea-level on the west to nineteen thousand feet, and down on the east to as low a level as possible. If we can get simultaneous observations at these stations, it seems to me that the results must be of great interest to meteorologists. I have begun some cloud observations, and in time may be able to throw some new light on the peculiar climate of this region. The Misti is now covered with enormous quantities of snow, and the last attempt to visit the station was unsuccessful. We hope, during certain weeks of the year, to visit the station daily, and make frequent mercurial readings as a check on the self-recording instruments."

New England Meteorological Society. — The thirtieth regular meeting of the New England Meteorological Society was held at the Massachusetts Institute of Technology, Boston, on April 21, 1894, President Wm. H. Niles, in the chair.

The committee appointed Jan. 27, 1894, consisting of Profs. W. M. Davis and Winslow Upton, and Mr. R. DeC. Ward, to consider and report upon action that might be taken by or through the Society regarding practical instruction to teachers on the use of the weather maps in schools, submitted the following report: —

It does not appear practicable at present to secure any compensation

from the school authorities of Boston or Cambridge for the contemplated exercises for next year; although it is thought that by laying plans for at least a year in advance, some such arrangement might be made. It does, however, appear possible to announce the following plan, for which the approval of the Society is asked.

The committee will offer to the School Committee of Cambridge to supervise a series of practical exercises on the use of the weather maps in the grammar schools, the plan of the work being in accordance with the report on geography in the Report of the Committee of Ten on Secondary Schools, the work to be of a directly practical nature, such as the scholars might afterwards repeat; the exercises to be gratuitous in Cambridge.

The Committee will furthermore supervise the repetition of this course in neighboring cities, provided a moderate compensation can be made to the instructors.

It is believed that not less than five weekly exercises should be given; and that the course might be advisedly extended to ten.

On motion of Mr. H. H. Clayton, the above report was adopted and the committee was continued with power to act in accordance with the plan of the report.

The treasurer, Mr. R. DeC. Ward, made an informal statement of the finances of the Society, showing that eighty paid members are on the books, after several names have been crossed off for non-payment of dues. A balance of seventy-five dollars stands in the treasury.

Prof. Winslow Upton, director of the Ladd Observatory, Providence, R. I., read a final report on his investigations on the distribution of cyclonic rainfall in New England.

Prof. W. M. Davis, of Harvard College, read an essay on "Climatic Control of Topography."

Mr. R. DeC. Ward, editor of the AMERICAN METEOROLOGICAL JOURNAL, exhibited and commented on a number of recent publications.

The papers read by Profs. Upton and Davis will be published in the JOURNAL.

CORRESPONDENCE.

THE AURORA OF MARCH 30, 1894.

Editor of the American Meteorological Journal:

The aurora of Friday evening, March 30, was first seen at Lyons, N. Y., at 7.40 P. M. It then consisted of flickering, irregular patches which filled the entire heavens from the zenith down to the southern horizon, there being nothing whatever to be seen in the usual location of auroras toward the north. This distribution of the display continued with some variations in brightness until 8.38 P. M., standard time, when streamers began to form northward for the first time during the evening, and the heavens became luminous in that direction, presenting an appearance sim-

ilar to that previously seen toward the south. Fortunately, quite a large number of observers are making concerted observations of the aurora from South Carolina northward in the vicinity of the 77th meridian into Canada. From the reports thus far received, it appears that at the hour above indicated, the aurora was seen toward the south exclusively at stations directly north of Lyons, while southward in Pennsylvania the entire sky was more or less covered with flickering patches and masses of light, and still further south the aurora was seen toward the north exclusively, at Charleston, S. C., rising about 25° above the northern horizon. Thus it appears that the central point of luminous mass at the longitude named was probably within the bounds of the State of Pennsylvania. A similar distribution in latitude has been noticed in some other instances, heretofore, but has not been so strongly defined.

As regards the solar conditions attendant upon this aurora, they were precisely such as have been pointed out by the writer as being characteristic. There was a disturbed area at the eastern limb containing two spots which were exactly at the edge at the time, and in which other spots have been forming during the transit, all being located far south of the solar equator, which has been found to be the proper location to have an auroral effect at this season of the year. It is true that the spots mentioned were not prominent, but the point is that they were in the right location. In other words, it is not the size of the spots but their position that determines the auroral effect. Thus in this very case also there was a repetition of the aurora at the synodic rotation period of the sun on March 3, when the same disturbed area was again at the limb. Casual observers, however, as a rule refer outbreaks of the aurora to whatever spots happen to be most conspicuous at the time without reference to periodic recurrence at the rotation period of the sun, and irrespective of the fact that such conspicuous spots remain in view as a rule nearly fourteen days without corresponding continuance of the aurora. The proper method is simply to inquire whenever an aurora is seen whether there is a disturbed area upon the sun in the characteristic location at the eastern limb and in the vicinity of the plane of the earth's orbit at that point, and likewise whether there is any history of repetitions both of the aurora and of the solar conditions at the synodic rotation period of the sun, or in other words, at intervals of about 27¼ days.

M. A. VEEDER.

LYONS, N. Y., April 7, 1894.

BIBLIOGRAPHICAL NOTES.

PSYCHROMETER TABLES.

Psychrometer-tafeln für das Hunderttheilige Thermometer nach H. Wild's Tafeln bearbeitet von C. Jelinek. Vierte Erweiterte Auflage. 4to. Wien, 1894.

This is a fourth edition of a set of tables in quarto for the use of the psychrometer. The short table contains 6 pages, and the longer table for

the same purpose 85 pages. The formula used was that developed by Regnault, in 1845, as follows: —

$$X = f - \frac{0.480\,(t - t')\,h}{689 - t'} \quad t' \lessdot 0^\circ$$

For $t' > 0°$ the denominator is changed to $610 - t'$. These tables apply to an unventilated instrument outdoors. In a high wind or with artificial ventilation, the vapor pressure and relative humidity obtained from these tables will be too low. It is gratifying to find the vapor pressure and relative humidity given side by side, a custom which has prevailed in some tables in this country since 1886. We cannot say as much, however, regarding the arrangement of the table with the wet bulb reading as the argument. This increases the length of the table enormously, and makes the research for a single reduction quite a tedious operation. As the use of artificial ventilation increases in Europe, and, in fact, was introduced a great many years ago in Russia, such tables will have to be modified to correspond with the latest experiments in this line.

Hz.

April 25, 1894.

REPORT OF THE CHICAGO METEOROLOGICAL CONGRESS.

Report of the International Meteorological Congress held at Chicago, Ill. Aug. 21–24, 1893, *under the Auspices of the Congress Auxiliary of the World's Columbian Exposition.* Part I. Edited by Oliver L. Fassig, Secretary. U. S. Department of Agriculture, Weather Bureau, Bulletin No. 11. 8vo. Washington, D. C., 1894. Pages xiv, 206. Pl. x.

The first part of the Report of the Meteorological Congress held at Chicago last August has been issued as Bulletin No. 11, of the Weather Bureau, and is an extremely valuable publication, of over two hundred pages. It is preceded by the Minutes of the Congress, and contains papers read before the sections on Weather Services and Methods, Rivers and Floods, and Marine Meteorology. We have already published in this Journal (September, 1893, 222; November, 1893, 316; January, 1894, 398), the titles of papers prepared for the Congress, and in the January number printed a number of abstracts of the papers read. We intend to reprint many of these articles, either entire or in abstract, in this Journal, and shall therefore omit any review of this Bulletin at present.

It is difficult to overestimate the importance of this publication, which is the outcome of the Chicago Meteorological Congress. It was the purpose of the Congress "to collect a series of memoirs prepared by writers of recognized merit in their respective fields of labor, outlining the progress and summarizing the present state of knowledge of the subject treated." At the present time, when such rapid progress is being made in the various branches of meteorology, it is a great satisfaction for the student to be able to refer to articles written by authorities on the different subjects, which give a *résumé* of what is now known in each case. It is with this feeling of satisfaction that we regard this collection of papers, and we are sure that most of those who see this Report will have the same feeling.

The contents of Part I. is as follows: —

Section I. — Weather Services and Methods.

1. Meteorological stations and the publication of results of observation. Prof. Dr. J. Hann, Director Austrian Meteorological Service, Vienna.

2. The publication of weather maps and bulletins. Robert H. Scott, Secretary Royal Meteorological Council, London.

3. Functions of State weather services. Maj. H. H. C. Dunwoody, U. S. Army, Assistant Chief U. S. Weather Bureau, Washington, D. C.

4. The predictions of droughts in India. W. L. Dallas, Assistant Meteorological Reporter to the Government of India, Calcutta.

5. Can we, by automatic records, at three selected stations determine the energy of a flash of lightning? Alexander McAdie, M. A., U. S. Weather Bureau, Washington, D. C.

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